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**Trends in Soviet Science
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TRENDS IN SOVIET SCIENCE AND TECHNOLOGY

THE PROBLEM

To present a general appraisal of the principal strengths and weaknesses of Soviet science and technology, and to estimate, in broad terms, the main trends of development over the next decade.

FOREWORD

This estimate is intended to present a brief general appreciation of Soviet science and technology. For extensive technical analysis relating to the subject, reference should be made to "Soviet Science and Technology Through 1971," an interdepartmental research study prepared by the Scientific Intelligence Committee, the Summary and Conclusions of which were approved by USIB on 23 May 1962. Specific applications of Soviet science and technology will also be covered in the following scheduled national intelligence estimates:

- a. NIE 11-1-62, "Soviet Space Programs"
- b. NIE 11-2-62, "Soviet Atomic Energy Program"
- c. NIE 11-3-62, "Bloc Air Defense"
- d. NIE 11-4-62, "Soviet Military Capabilities"
- e. NIE 11-8-62, "Soviet Strategic Attack Capabilities"
- f. NIE 11-11-62, "Trends in the Soviet Economy"

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THE ESTIMATE

I. SOVIET APPRECIATION OF SCIENCE AND TECHNOLOGY

1. The Soviet leadership fosters scientific and technological progress as basic to the growth of Soviet military, economic, and political power. The Soviet state inherited from prerevolutionary Russia a relatively backward technology, but a highly sophisticated, though quantitatively limited, scientific base. During the 1930's, the USSR deliberately undertook to force the development of scientific and technical education and the expansion of research facilities in order to provide a stronger foundation for future development. This farsighted program has paid off in the impressive progress achieved during the 1950's. This progress also reflects the power of the Soviet state to concentrate limited resources on the achievement of selected priority objectives. To date Soviet scientific and technological effort has been focused primarily on the development of modern weapons and the building of a strong industrial base. We believe that these priorities will continue. Even so, sufficient resources and experience are now available to enable the USSR to make important advances over a considerably wider range of scientific fields.

2. Soviet scientific progress is fostered by the high place assigned to scientists in Soviet society. Soviet scientists have long constituted a privileged group in terms of social position and financial status. They enjoy great popular esteem derived in part from traditional European attitudes toward learning and in part from the influence of an ideology which exalts science. An additional attraction is that many scientific fields permit an escape from immediate political involvement which is not possible in many other professional

fields. Soviet scientists as a group appear to be dedicated to their work, politically loyal or at least apolitical, and often animated by a spirit of competition with the US. Party control of science is now directed primarily toward identifying areas of research that offer the most promise for application, setting priorities, and achieving effective administration, rather than interfering with methods of research. However, in certain fields which have acquired political implications, notably genetics, party interference has held back significant work.

3. The working relationship between the political leadership and the scientific community is enhanced by the fact that many party leaders have had technical training or experience in the management of technical enterprises. As technological considerations have become an important factor in Kremlin decisions, the participation of professional scientists in such deliberations has increased and this trend will continue. In general, however, we think it likely that the influence of professional scientists, like that of other experts, does not extend much beyond their areas of special competence.

4. The Soviet political leaders have encouraged popular interest in science and have sought to identify themselves, and communism, with Soviet scientific successes. In recent years, these achievements have enhanced the popularity of the regime. The people appear to share the regime's confidence in limitless scientific advancement and are proud of the ability of the USSR to achieve successes in some cases prior to more advanced countries of the West. However, consumer benefits accruing from the regime's interest in science and technology have been modest and there is some sentiment that the government

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should devote more of its resources to raising living standards and less to reaching the moon.

5. In external relations also, the USSR has made effective use of the prestige resulting from Soviet achievements in science and technology to cultivate the idea that the Soviet system is best suited for the achievement of rapid technological and social progress. This idea is projected through intensive propaganda, technical aid to underdeveloped countries, trade fairs, exhibitions, visiting lecturers, and attendance at international scientific conferences.

II. SCIENTIFIC AND TECHNICAL RESOURCES OF THE USSR

6. Soviet scientific resources in manpower, research facilities, and funds, and the program for exploiting foreign scientific and technical developments, are impressive and will continue to increase and improve. The Soviets are also supporting the expansion of the scientific base in the European Bloc countries which in turn contribute to the scientific resources available to the USSR. However, we believe that these scientific resources are not adequate to support the ambitious goals stated or implied in the 20-Year Program adopted by the XXII Party Congress.

7. The scientific manpower base continues to expand in numbers and improve in quality. The USSR now has approximately 750,000 persons, including all levels of technical personnel, engaged in scientific research and development, and this group probably will exceed one million by 1965.¹ Generally speaking, Soviet planning for a wide range of research and development activities will not be

¹ Comparisons between scientific manpower totals for the US and USSR are generally misleading because of wide differences in classification criteria, training and experience levels, and utilization practices. A detailed statement on Soviet scientific manpower appears in the SIC study, "Soviet Science and Technology Through 1971," dated 23 May 1962, pages B1-B6.

severely restricted by shortages of trained personnel.

8. Although the quality of Soviet technical education varies widely, higher standards have been achieved and maintained since the end of World War II, particularly in engineering and the physical sciences. The major portion of personnel presently engaged in research and development were graduated during this period; their potential has not yet been fully realized. As this group gains experience and influence, Western pre-eminence will be increasingly challenged in many fields of science.

9. While the numbers of research and development personnel have expanded rapidly, improvement in the quality and quantity of research facilities has not kept pace. The number of research institutions has increased about 40 percent during 1956-1961, but many research organizations are housed in inadequate, makeshift quarters and are further hampered by lack of equipment. The high priority of research relating to military programs and heavy industry has resulted in an unbalanced distribution of research facilities and equipment, both geographically and by field of study. The Seven-Year Plan's ambitious goals for a large increase in the number and marked improvement in the quality of research institutions will probably not be attained by 1965 as planned, but will be reached well before the end of the decade. As the network of research institutions grows, many new installations will be located outside the traditional centers of Moscow and Leningrad in order to promote the training and use of local personnel and to foster closer relations between research activities and the industries which they support.

10. Soviet science has traditionally emphasized theory. Until recently in many fields, and even today in some, experimental verification and application to product development have been weak points. As a result, though

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Soviet scientists have excelled in a number of theoretical fields, there has been difficulty in harnessing their scientific knowledge for practical purposes. The regime has been making a major effort to correct this situation by incentives, reorganization, and educational reforms. When Soviet capabilities for experimentation and application become more generally developed, the USSR will be able to derive even more advantage from its excellence in theoretical science.

11. Soviet concern over difficulties in translating research results into practice has been a major reason for the successive reorganizations of the administration of scientific activities during recent years. Since 1957, steps have been underway to associate research and development activities more closely with production facilities. In the most recent reorganization, in April 1961, the Academy of Sciences was relieved of its applied research responsibilities and freed to concentrate on fundamental and theoretical research. At the same time, a State Committee for the Coordination of Scientific Research Work was established to provide centralized coordination for certain key areas of research and development and to strengthen scientific capabilities generally. Despite the many organizational changes that have taken place during the past few years, readjustments undoubtedly will continue, as the Soviets probably have not yet found satisfactory ways of coordinating all work and of insuring continuity between research and production over a broad front, as distinguished from selected high priority areas.

12. The Soviet scientific research effort is supported by intensive programs to collect and disseminate scientific and technical information. The All-Union Institute of Scientific and Technical Information, with a permanent staff of 2,000 and an additional 20,000 part-time abstractors, is the largest technical information center in the world. It concentrates on translating, abstracting, and editing

foreign scientific literature, but also processes technical information published in the USSR. Nevertheless, the Soviets still have difficulty in making technical information available promptly and in usable form to researchers who need it. In this connection the Soviets are conducting intensive research on use of computers for translating and information processing. They are also seeking to remedy a general shortage of up-to-date reference books and high quality periodical literature on the latest technological practices.

13. Considerable improvement in Soviet research capabilities and technology has resulted from the acquisition of plants, machinery, instruments, and technology from abroad. By this means, the USSR has saved itself many years of independent research and development in such fields as advanced instrumentation, rare metals, and plastics. The Soviet Union continues an intensive program to purchase Western industrial equipment and industrial technology, primarily from the US, UK, West Germany, and Japan and the tempo of advance in certain fields will depend in a considerable measure on the success of these efforts. We believe that a principal motivation for the Soviets' recent interest in exchanging patents with the US is the prospect of acquiring technology from US firms. Soviet intelligence services also contribute to the exploitation of foreign technology. They devote a major part of their operational activities to the collection of scientific and technical intelligence, primarily in military fields.

III. CURRENT CAPABILITIES AND FUTURE PROSPECTS

14. Soviet science and technology as a whole remains inferior to that in the West, although the best Soviet scientists are on a par with their leading Western counterparts. Soviet scientists have made noteworthy progress in certain engineering fields and in the theoretical aspects of certain basic sciences, particu-

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larly physics, mathematics, and the geophysical sciences. Progress has been slower in scientific fields less directly related to industrial development and military power, such as biology and medicine. The Soviet policy of concentrating resources has led to significant achievements in military technology and certain segments of industry; in some specific areas, they now equal or surpass the West. In many other fields, they are intent upon narrowing or erasing the present Western lead during the coming decade.

15. We believe that the development of new weapons systems and a strong technology in defense-supporting industries will continue to receive first priority in Soviet scientific efforts. The 20-year economic program recently adopted indicates, at the same time, that increased emphasis will be given to the application of science and technology to strengthen the civil economy and thus the Soviet capability for nonmilitary competition with the West.

16. The Soviet regime apparently intends to apply to a select list of scientific-technological tasks certain managerial techniques derived from successful high priority military programs such as nuclear weapons and guided missile systems. These techniques feature a high degree of control and coordination of the scientific and technical, theoretical and experimental, aspects of an entire program, as well as more effective provisions for advance planning and financing. These tasks include such research problems as controlled thermonuclear reactions, efficient direct conversion of heat into electrical energy, and automatic control of industrial processes. Analogous approaches are being applied also in areas of research and development of lesser priority. The current policy of the regime is to plan and coordinate the work of institutions at all organizational levels so as to focus their attention on the key tasks in their areas. In the fundamental sciences, scientists are directed

to select and concentrate on the most promising research topics.

Military Programs

17. Concentration of scientific and technological effort is producing impressive weapons systems for Soviet air, ground, and naval forces. Major allocations of facilities, funds, and equipment are given to priority areas of military research, and numerous research institutes, proving grounds, and test facilities are devoted to a number of specific weapons. A considerable amount of basic research in the Academy of Sciences and higher educational institutions is probably supported because of promise in military fields.

18. The USSR's military forces have been modernized extensively during the last decade, most significantly in the development of nuclear weapons and their means of delivery. Analysis of the 1961 test series indicates that major advances have taken place in Soviet nuclear weapons designs. The Soviets have demonstrated a highly sophisticated thermonuclear weapons technology, and they have a high potential for continuing such advances in the future. With respect to missiles, considering present Soviet technology and a probable continued high priority, we believe that a wide range of improved characteristics will be incorporated in future systems.

19. The production of a succession of improved jet interceptors continues, but we believe that Soviet air frame and engine developments have been hampered by reliance upon theoretical design to the neglect of empirical testing. Soviet air forces are being extensively equipped with a variety of air-to-surface and air-to-air missiles, and the USSR continues to develop an effective semiautomatic control system for air defense fighter forces. Impressive advances in missiles, rockets, and artillery and an extensive vehicular re-equipment program have already improved the fire power and mobility of ground forces. The

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USSR has an extensive chemical warfare (CW) program; we believe that troops are well equipped with munitions and protective equipment and are well trained in their use. Naval forces continue to be strengthened by the installation of missiles on warships; new classes of missile-equipped ships include destroyers, submarines, and patrol craft.

20. We believe that the USSR will continue to devote substantial scientific effort to strengthening its armed forces by improving the performance characteristics of weapons and equipments already developed. In addition, the Soviets probably will emphasize the development of new systems, such as improved detection equipment and underwater weapons for Soviet antisubmarine warfare (ASW) forces, although the USSR will have only a limited ASW capability in areas beyond coastal waters during the next few years. The USSR lags behind the US in marine nuclear propulsion systems, but the Soviets will probably continue to develop nuclear propulsion for ships. They may develop nuclear propulsion for aircraft as well. The USSR will also probably emphasize research in magnetohydrodynamics, because of specific applications to controlled thermonuclear reactions and the reentry problem. We believe that the USSR has a program for the military use of space, although their accomplishments to date have not disclosed the specific manner in which they intend to use space for the projection of military power.

21. The USSR will continue its large and intensive program to develop missile systems for defense against ballistic missiles. We believe that this program is directed toward defense against all types of ballistic missiles, and even against satellites, although most of the research and testing to date has involved developing terminal intercept techniques against short and medium-range missiles. The USSR is also conducting basic research which might

eventually lead to methods of employing highly concentrated beams of energy or particles in defense against aircraft, missiles, and space vehicles, although we have not identified a specific weapon program in this area.

Space Program

22. During the next decade, we believe that the USSR will direct an increasingly strong scientific effort toward its space program. To date the program has resulted in the achievement of a series of spectacular firsts. While this Soviet program has been impressive, there has been an apparent lack of systematic and comprehensive in-flight measurement of the space environment necessary to continued progress in the future. The recently inaugurated series of "Cosmos" satellites, which may represent the beginning of a broader space research program, suggests that the Soviets are now taking steps to remedy this weakness.

23. Generally, the Soviet ICBM and space programs are mutually supporting. Until the "Cosmos" series, all major space events have involved the first generation ICBM booster and their successes have been largely attributable to its payload capacity. This booster could be used to achieve additional successes now, such as placing two men into earth orbit, soft-landing an instrumented package on the moon, or orbiting a lunar satellite. However, more advanced space missions, such as manned lunar flight, will require far more powerful boosters than those now in use, as well as comparable advances in instrumentation, communications, guidance, electric power supply, tracking, and other related fields. The USSR may also be working on nuclear or ionic propulsion systems for space applications. In short, the Soviets must develop a more advanced technological foundation than that gained in their early days of military rocketry.

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Economic Programs

24. Soviet industry is characterized by marked qualitative unevenness in technological practices between industrial sectors, and even within certain sectors which are generally well developed. In heavy industry, such as steel-making, techniques and equipment often compare favorably with those used in the West. However, industrial practices generally are inferior and sometimes even crude by Western standards, especially in consumer oriented industries. Despite the improvements likely to be made, the magnitude of this problem is so great that the average level of Soviet industrial technology will remain well behind that of the West through the next 10 years. Soviet agricultural technology has advanced very unevenly, and in most sectors lags far behind that of the West.

25. The continuing Soviet stress on economic growth has caused the leadership to place increasingly heavy emphasis upon more efficient utilization of resources. Significant advances in this respect could be achieved by the wider use of existing technology. For example, investment in materials handling facilities and the development of plant specialization would yield large increases in labor productivity. The unrealized potential of existing technology is particularly evident in the key problem area of agriculture, where significant gains could be achieved through broader investment in already developed machinery and equipment, improved seed and animal strains, fertilizers, and the use of intensive farming techniques.

26. Automation will probably contribute significantly to the attainment of Soviet long-

range industrial objectives. The current Seven-Year Plan for automation is essentially experimental, as indicated by the designation of some 80 industrial installations as model experimental plants. An extensive research and development program is underway which in 10 to 15 years probably will produce radical innovations in computer design and in self-learning machines capable of improving economic planning and the control of complex industrial processes. We believe that before 1980 the Soviets will attempt to introduce these developments in a wide variety of industries, but major investment programs will be required and difficulties in adapting technological developments to practical purposes will be encountered.

Summary

27. We believe that during the present decade the Soviets will move forward on a broad scientific front, although not at the rates they anticipate in all areas. Manpower qualifications in many disciplines will advance much more modestly than predicted publicly by Soviet leaders. Organizational difficulties will probably continue, particularly in translating the results of research into practice. Nevertheless, by continuing to concentrate efforts and resources, the USSR probably will achieve during the next few years a number of notable accomplishments in priority fields. The more spectacular Soviet achievements, particularly those in space, missiles, and nuclear weapons will continue to be used to foster an image of advanced scientific and technological capability in all fields and to bolster Soviet claims regarding the superiority of the socialist society.

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